PATENT SPECIFICATION

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(19)

(54) IMPROVEMENTS IN AND RELATING TO DIVING MASKS

(71) I, JOHN WILLIS HIESTAND, a citizen of the United States of America, residing at 5 Harlington Avenue, Hellesdon, Norwich, in the County of Norfolk, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention concerns diving masks of the type which cover the whole face and are held in place on the head by band means passing therearound and attached to the mask. Such a mask is described as a full facial diving mask and reference herein to a mask are to a full facial mask.

It is common to use a full facial mask with a hood of elastomeric or like, waterproof material forming part of a diving suit. Since, when combined with such a hood, the whole of the head is covered, the combination of hood and mask has been described as a diving helmet.

Basic objects of the present invention are separately and in combination to provide a full facial diving mask which, — is less susceptible to damage than present designs, — has a breathing gas demand regulator including a flexible diaphragm the design of which is such as to allow the wearer readily to prevent the ingress of water due to damage or failure of the diaphragm, — has a lower exhalation resistance than present designs, and, — will more readily accommodate movement of the head than will present designs.

According to the present invention in a full facial diving mask comprising a rigid shell having a viewing aperture, means for supplying thereto gas under pressure and exhausting gas therefrom and a demand type gas regulator for controlling the admission of fresh gas, the gas regulator is wholly contained within the rigid shell and a pressure responsive device of the regulator communicates with the exterior of the mask via at least one port in the shell.

It is known to provide a gas manifold on the exterior of the shell and to connect the umbilical (gasline from surface gas supply) via a non-return valve to the manifold.

According to a preferred feature of the invention the gas pipe supplying gas from the manifold to the regulator is also contained within the rigid shell.

In order to obtain the full benefits of placing at least the regulator within the shell, the latter is preferably cast from gunmetal.

According to another prepared feature of the invention an exhaust valve is mounted in the pressure balancing device of the regulator. Where the pressure balancing device is a flexible diaphragm of e.g. rubber, the exhaust valve is conveniently mounted centrally in the diaphragm.

Conveniently the exhaust port means for the exhaust valve is the port or ports by which the pressure balancing device of the regulator communicates with external pressure.

Where a further gas pipe connects the manifold to a reserve supply of gas carried by the diver, the connection between the further gas pipe and manifold preferably provides for relative movement between the pipe and manifold.

The invention will now be described by way of example with reference to the drawings accompanying the provisional specification, in which:—

Fig. 1 is a front view of a full facial diving mask,

Fig. 2 is a cross section on the line II—II of Fig. 1,

Fig. 3 is an exploded perspective view of the diving mask of Fig. 1 to a different scale together with a hood therefor, and

Fig. 4 is an exploded perspective view of a gas manifold and valve assembly (to a different scale).

This mask provides a safe breathing apparatus for the commercial diver. Its unique design provides safety aspects which

previous diving masks and helmets lack. Its design is streamlined and reduces the amount of protrusions and outward obstructions which characterize other masks. Its frontal profile, by being low reduces water drag to the diver's head. Two types of gas supply are incorporated in the mask, free-flow and demand.

A mask shell 10 (see Fig. 1) is cast in gun-metal (Admiralty Specification G 1), thus obtaining a shell of high strength which will not collapse under differentials of pressure. If a rapid decrease of pressure occurs in a breathing gas hose 12 (e.g. in the case of it being severed) a vacuum condition will exist at great jeopardy to the diver. The mask provides a robust non-return valve in a housing 16 on a gas manifold 14, which will allow the breathing gas to pass in one direction only. The breathing hose, if severed, will not produce a painful squeeze to the diver because at the slightest back pressure the valve will close, thus preventing the breathing gas from being sucked from the mask. The diver would then switch on his emergency supply of gas.

The non-return valve housing 16 includes a banjo-type connection between it and the gas manifold 14. Previous masks have rigid connections whereby the breating gas hose restricts the diver's head movements. The banjo-type connection is permitted to swivel 180°, thus reducing the strain on the side of the diver's head.

The gas manifold 14 is unique in its design in that it can be replaced quickly whereas previous masks required the manifold valves to be sealed to the mask with a rubberized silicone solution which necessitated a twenty-four hour curing time. It is also unique in that an internal connection is made from it to a second-stage demand valve 24 (see Fig. 2), via a pipe 18, whereas previous types (if a demand valve was employed) were externally connected from manifold to demand valve, thus exposing this whole connection to damage or deteriorating effects of salt water. A connection covered by a cap 20 and a valve-controlling knob 22 are provided for an emergency breathing gas supply. With an adaptor this connection can be used as a controlled gas source for use in inflating underwater lifting devices etc.

When in use the diver will normally obtain gas for breathing from the second-stage demand valve 24 (see Fig. 2), but if additional breathing gas is required or the diver wishes to purge water from the mask or flush the mask of any CO_2 build-up, a free-flow valve controlled by knob 26 is provided for this purpose. When the free-flow valve is opened and free flowing gas enters the mask it passes through a distribution nozzle 28 (see Fig. 4) which directs the gas in nine different directions.

Prior masks and helmets which provide a demand breathing valve have these devices as separate items from the mask which are either clamped, screwed, or stuck to the front of the mask. By designing a cast housing 30 which houses the front half of the demand valve, the problem of securing the demand valve to the mask is overcome. This method also protects the demand valve from damage if a blow is sustained, while other masks using standard demand valves which are exposed, suffer damage if they receive a frontal blow. Destruction tests show that if a specified weight is dropped a measured distance perpendicular to the front of a mask incorporating a standard external demand valve, the blow will not only crush the external valve rendering it inoperative, but will also allow sea water to enter the mask. A blow of the same type sustained by the front of the improved mask may at most dent the front of the demand valve housing 30 but the latter will continue to function and no salt water will enter the mask.

The overall frontal and side protection afforded to the diver equipped with this mask is greatly enhanced. The mask being cast in gun-metal is of high strength compared with other non-porous materials and is also extremely resistant to the corrosive effects of salt water. Divers working in the off-shore oil-fields are increasingly being employed on work and installations having high pressure hydraulic systems. While accidents are not common these systems have been known to shatter or explode.

While other types of masks made of fibre-glass or similar materials are extremely overbalanced by the large metal gas manifold which is placed on one side, the cast gun-metal shell of the improved mask offers better balance when placed on the diver's head. Being better balanced it is therefore more comfortable for the diver to wear.

The demand valve employed in the improved mask is totally protected from the surrounding sea water regardless of depth. It will be shown that this unique feature is a major breakthrough in the field of safety for the commercial diver. Previous masks and helmets which employ a demand breathing device, use an activating diaphragm made of rubber or other suitable flexible material and an exhaust flapper valve made of similar material. These diaphragms and valves are in time subject to deterioration and therefore must be replaced. The diaphragms must be exposed to sea water in order to maintain balanced pressures both inside and outside the demand valve assembly. By exposing the diaphragm it is theoretically possible to puncture or rupture it from without. While in use, if the diaphragm was

punctured, or ruptured due to deterioration, or the retaining clamp which holds the outer housing to the demand valve became damaged and broke off, surrounding water would flow directly into the mask. If a diver found himself in this situation he could normally do little else but immediately execute an emergency ascent. The improved mask overcomes this danger. Surrounding pressure is exposed to the diaphragm 32 via exhaust ports 34. The diaphragm is fully protected from being punctured from the front.

If the diaphragm was ruptured due to deterioration, water could flow directly into the mask as in any other, but if this were to happen the diver could quickly place thumb and middle finger of one hand over the exhaust ports — thereby producing a complete seal from the outside water. The other hand is left free allowing the diver to turn knob 26 and open the free-flow valve. Any water which may have entered the mask will then be expelled via a subsidiary flapper valve 36 in a housing 38 and the diver can ascend in safety and may even make decompression stops if necessary.

A normal exhaust flapper valve is mounted in the centre of the diaphragm 32. When the diver inhales the assembly functions as a normal diaphragm. On exhalation the flap 40 opens, expelling the spent gas. This in effect permits exhalation through the diaphragm. This feature is most important because it allows for less exhalation resistance, whereas other designs have a separate diaphragm and flapper exhaust valve.

The face port is covered by a transparent polyvinyl chloride sheet.

To reduce the build-up of CO_2, an oral-nasal mask 42 is employed. The oral-nasal mask communicates with the housing of the demand valve 24 and includes a drainage aperture 44 (see Fig. 3).

Two terminals 46 are provided for connecting communications leads between the interior and exterior of the mask.

The face port material is preferably of optically clear polyvinyl chloride as described but polycarbonate may alternatively be employed.

Referring specifically to Fig. 3, the mask assembly is designed to be fitted to a diving hood 48 which is typically of gas blown closed cell Neoprene from which wet suit diving dress is conventionally manufactured. A ring 50 of open celled foam is fixed inside the opening of the hood 48, through which the diver's face protrudes. A thin layer 52 of closed cell Neoprene (approximately 1/8'' thick) is fixed to the inside of the foam ring and it is this layer of Neoprene which provides the seal against the diver's face and prevents water from entering the mask in use.

The mask shell 10 is secured to the hood 48 by means of a two-part clamp 54, 56. The two parts of the clamp are joined by screws 58 which pass through clearance holes in blocks 60 and threadedly engage tapped holes in blocks 62.

The clamp is located in front of a flange 64 (best seen at the top of the shell 10 in Fig. 3) and by virtue of posts 66 provides a mounting for the arms 68 of a rubber strap assembly generally designated 70 and shown in the top left hand corner of Fig. 3. Each arm 68 includes a number of holes 72 and the holes are selected so as to provide the correct tension of the mask on the diver's face and to hold it firmly in position.

The shell 10 includes a viewing aperture 74 which is covered by a plate 76 of transparent material (preferably optically clear polyvinyl chloride) which is held in place by an outer sealing flange 78 and screws 80 (see Fig. 1) which pass through aligned holes in the plate 76 and flange 78 and are threadedly engaged in tapped holes in the shell. A rubber gasket 81 provides a seal between the plate 76 and shell 10.

The lower half of the front of the shell 10 includes a recess 82 in its rear surface (see Fig. 2) having a central aperture 84. The recess 82 accommodates the peripheral flange 86 of a rubber diaphragm 32 (previously described) and the peripheral flange of a housing of the demand valve 24. The housing is secured to the shell 10 by screws (not shown) which pass through aligned holes 88 in the housing and peripheral flange 86 (see Fig. 3). The diaphragm 32 extends through the central aperture 84.

The aperture 84 is covered by a front housing portion 90 having formed therein a transversely extending passage which communicates with the aperture 84 and is open at each end on opposite sides of the housing 90 to provide the exhaust ports 34 (previously described).

The interior of the demand valve 24 is illustrated in Fig. 2. Gas is suppied by pipe 18 to a supply nozzle 92 which is covered by a closure member 94 in a tubular housing 96. The closure member 94 is urged against the nozzle 92 by a piston 98 acted on by a compression spring 100 which acts through a thrust member 102 of adjustable length to permit adjustment of the force acting against the valve closure member 94. The diaphragm 32 acts on one end of a lever 104 which is linked to the piston 98 so that inward movement of the diaphragm causes the piston 98 to move away from the valve closure member 94. The diaphragm 32 will move in this way when the diver inhales

(which causes a reduction in pressure within the oral-nasal mask 42 which communicates with the interior of the demand valve housing to which it is attached).

When the diver exhales the pressure within the oral-nasal mask and demand valve housing increases and the flap 40 is momentarily urged away from the diaphragm 32 to allow air to escape through the central aperture in the diaphragm 32 through which a centre spigot 106 attached to the rear of the flap 40, extends. The latter is conveniently retained in position by the end of the lever 104 extending through an aperture in the spigot 106.

The gas manifold 14 is shown in detail in Fig. 4. A breathing gas hose 12 (shown in Fig. 1) is connected to an inlet 108 of a valve housing 16 containing a non-return ball valve (not shown) which allows air to pass from inlet 108 to outlet 110 but not in the reverse direction. The inlet 108 is pivotable about the axis of the manifold 14 to reduce the drag imposed by the breathing gas hose 12 on movement of the mask by the wearer.

The manifold 14 includes:—

1) a first externally threaded outlet spigot 112 which passes through a hole 114 in the shell 10, is secured therein by a nut 116 and to which the pipe 18 is connected, for supplying air to the demand valve 24,

2) a second externally threaded outlet spigot 118 which passes through a second hole 120 in the body 10, is likewise secured therein by a nut 122 and is covered by the distribution nozzle 28 having nine jets for distributing through flowing air in a number of different directions, and

3) a third externally threaded inlet/outlet spigot 124, normally covered by screw cap 20.

The flow of air through spigot 112 is controlled solely by the non-return valve in housing 16 and as called for by the demand valve 24.

The flow of air through spigot 118 is controlled by a needle valve having a threaded valve closure member 126 carried in a supporting spigot 128 and rotatable therein between closed and open closed positions, by a knob 26.

The flow of air through inlet/outlet spigot 124 is controlled by a second needle valve having a valve closure portion 129 carried at one end of a threaded valve member 130 which carries at its other end a knurled valve-controlling knob 22. The member 130 is threadedly engaged in a threaded aperture in one face of a hexagonal boss 132.

O-rings (only some of which are shown) are provided around the joints between the housing of valve 16 and manifold 14, and valve members 126 and 130 and their respective receiving apertures.

WHAT I CLAIM IS:—

1. A full facial diving mask of the type comprising a rigid shell having a viewing aperture, means for supplying thereto gas under pressure and exhausting gas therefrom and a demand type gas regulator for controlling the admission of fresh gas, in which the gas regulator is wholly contained within the rigid shell and a pressure responsive device of the regulator communicates with the exterior of the mask via at least one port in the shell.

2. A full facial diving mask as claimed in claim 1 in which a gas pipe supplying gas from a manifold mounted on the shell to the regulator is also contained within the rigid shell.

3. A full facial diving mask as claimed in claim 1 or claim 2 in which the shell is formed from metal preferably gun-metal.

4. A full facial diving mask as claimed in any of the claims 1 to 3 in which an exhaust valve is mounted in the pressure responsive device of the regulator.

5. A full facial diving mask as claimed in claim 4 in which the pressure responsive device is a flexible diaphragm.

6. A full facial diving mask as claimed in claim 5 in which the flexible diaphragm is formed from rubber.

7. A full facial diving mask as claimed in claim 5 or claim 6 in which the exhaust valve is mounted centrally in the diaphragm.

8. A full facial diving mask as claimed in any of the preceding claims 4—7 in which the exhaust valve includes port means by which the pressure responsive device of the regulator communicates with external pressure.

9. A full facial diving mask as claimed in any of the preceding claims in which a further gas pipe connects the manifold to a reserve supply of gas and in which the connection between the further gas pipe and manifold provides for relative movement between the pipe and manifold.

10. A full facial diving mask in which a demand type gas regulator is wholly contained within a rigid shell constructed arranged and adapted to operate substantially as hereinbefore described with reference to and as illustrated in Figs. 1 to 4 of the drawings accompanying the provisional specification.

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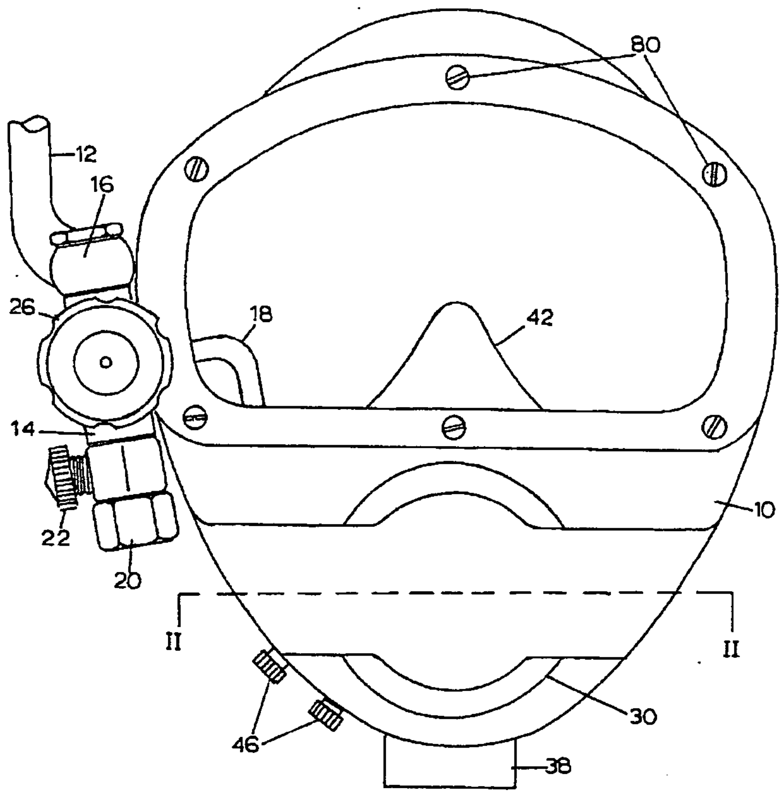
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FIG.1.

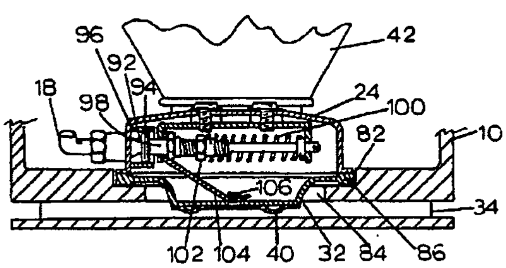
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FIG.2.

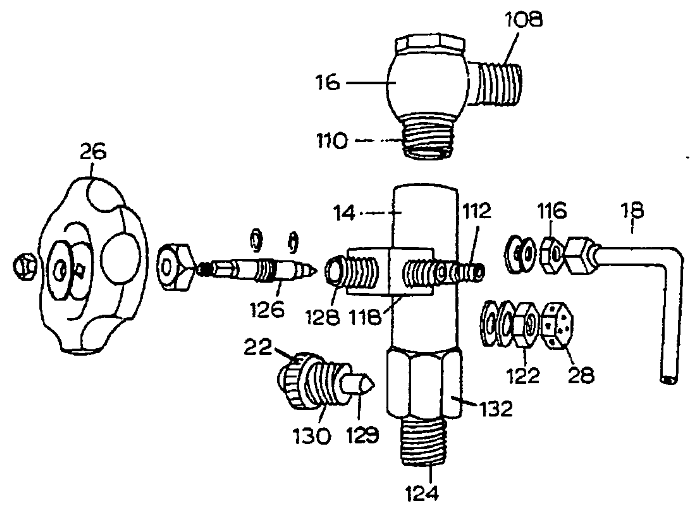

FIG.4

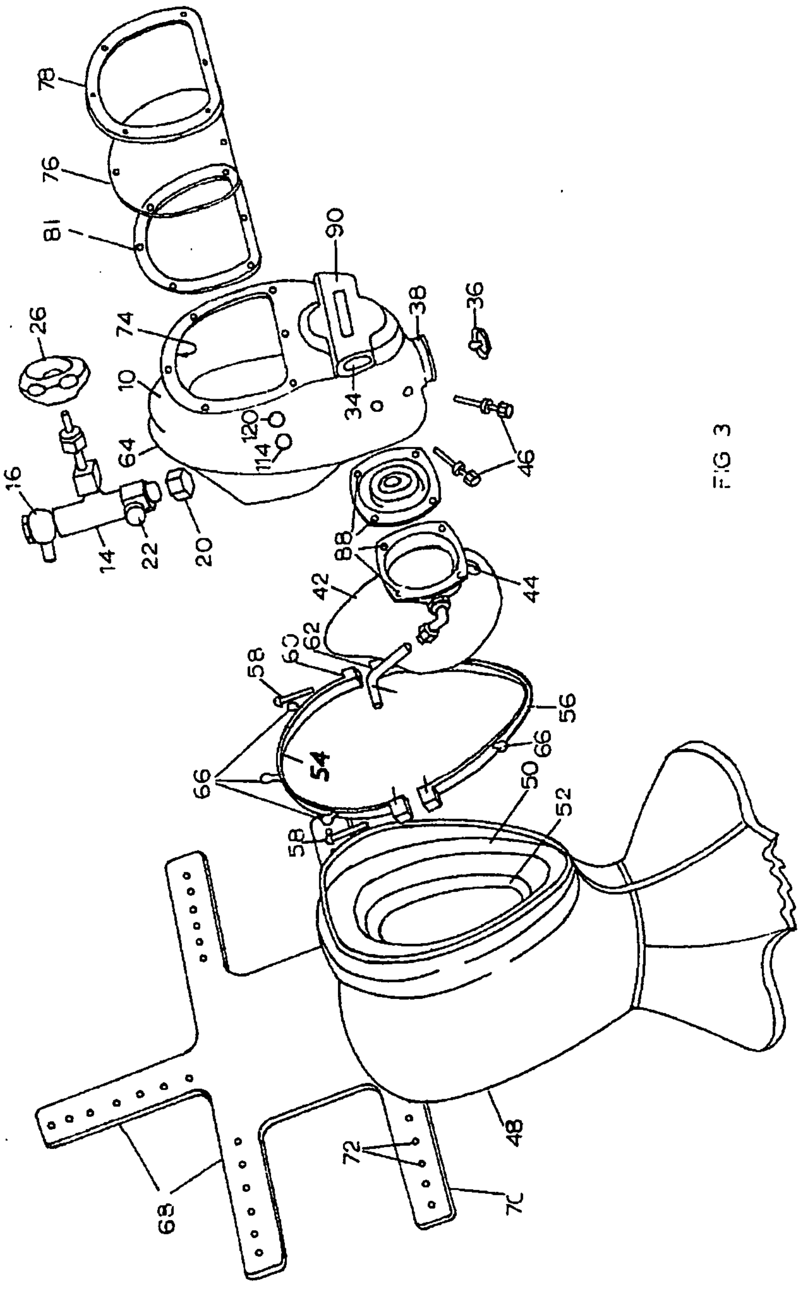
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FIG 3